

# Review on Smart Solar Powered Grass Cutter with Lawn Coverage

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## ABSTRACT

*The increasing demand for sustainable and automated systems has encouraged the development of eco-friendly solutions for everyday applications. Conventional lawn mowers rely on fossil fuels or grid electricity, leading to high operational costs, environmental pollution, and noise. This paper presents the design and implementation of a Smart Solar Grass Cutter with Lawn Coverage, an autonomous lawn-mowing system powered by renewable solar energy. The proposed system integrates a solar panel, rechargeable battery, DC motors, microcontroller, cutting mechanism, and obstacle-detection sensors to achieve efficient and safe lawn mowing. The developed prototype operates independently, reduces human effort, and minimizes environmental impact. Experimental evaluation demonstrates that the system is capable of performing effective grass cutting while ensuring optimized energy usage and complete lawn coverage.*

**Keywords**—Solar energy, automatic lawn mower, DC motor, obstacle detection, renewable energy.

## 1. INTRODUCTION

Lawn maintenance is an essential activity in residential areas, public parks, gardens, and institutional campuses. Traditional grass-cutting machines are either manually operated or powered by petrol engines. Manual machines require significant human effort, while petrol-driven mowers generate harmful emissions, noise pollution, and involve high fuel and maintenance costs. With advancements in renewable energy and embedded systems, automated and energy-efficient machines are becoming more feasible. Solar-powered devices provide a clean and sustainable alternative to conventional energy sources. Automation further enhances safety, reliability, and efficiency by reducing human intervention. The objective of this project is to design and implement a solar-powered, autonomous grass-cutting system that can perform lawn mowing efficiently while being environmentally friendly and cost-effective.

## 2. LITERATURE REVIEW

Several researchers have proposed automated lawn mowers using different technologies such as remote control, line following, and boundary-wire navigation. Obstacle detection using ultrasonic and infrared sensors is commonly employed to improve safety. Some advanced systems incorporate GPS-based navigation and mapping, but such designs significantly increase system cost and complexity. Previous studies have also explored solar-powered robotic systems; however, many designs focus either on automation or on renewable energy, but not both together in an optimized manner. The proposed system aims to integrate solar energy utilization with intelligent motion control and full lawn coverage, offering a low-cost and practical solution.

## 3. SYSTEM CONFIGURATION AND DESIGN

The block diagram shown in Fig. 3.1 illustrates the functional architecture of the solar automatic grass cutter system. The system consists of a solar panel, solar charge controller, lithium-ion battery, ESP32 microcontroller, DC motors, cutter motor, cutter blade, and a Wi-Fi communication module. The solar panel converts solar energy into electrical energy, which is regulated by the solar charge controller to safely charge the lithium-ion battery. The battery supplies a regulated 5 V DC power to the ESP32 microcontroller and associated electronic components. The ESP32 microcontroller acts as the central control unit of the system. It controls the DC motors connected to the wheels for movement and operates the cutter motor to drive the cutter blade for grass cutting. The built-in Wi-Fi capability of the ESP32 enables remote monitoring and control of the grass cutter through a mobile or web-based application.

Overall, Fig. 3.1 represents a solar-powered, Wi-Fi-enabled automatic grass cutting system designed for efficient, intelligent, and eco-friendly lawn maintenance.

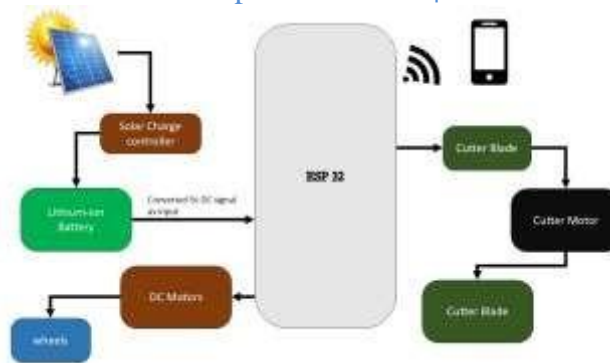


Fig. 3.1 Functional block diagram of the proposed solar powered grass cutter system

The Fig 3.1 illustrates the electrical connections and control mechanism of the solar automatic grass cutter system. The system is powered using renewable solar energy and controlled by an ESP32 microcontroller with Wi-Fi connectivity. A solar panel is connected to a solar battery charge controller, which regulates the charging of the battery and protects it from overcharging and reverse current. The battery stores the electrical energy and supplies power to the system during low sunlight conditions.

The battery output is connected to a DC-DC converter, which provides a regulated DC voltage suitable for powering the ESP32 microcontroller and other electronic components. The ESP32 acts as the main control unit and executes the control logic for movement and cutting operations. For motion control, the ESP32 drives the front and back DC motors through motor driver modules. These motor drivers allow the microcontroller to control the speed and direction of the motors, enabling smooth movement of the grass cutter. The cutter motor is operated using a relay module controlled by the ESP32. The relay provides electrical isolation and allows safe switching of the high-power cutter motor. The cutter motor rotates the cutting blade to perform grass cutting. The ESP32's built-in Wi-Fi enables wireless control of the system through a mobile device. Overall, the circuit diagram represents an efficient, solar-powered, Wi-Fi-based automatic grass cutter system designed for reliable and eco-friendly lawn maintenance.

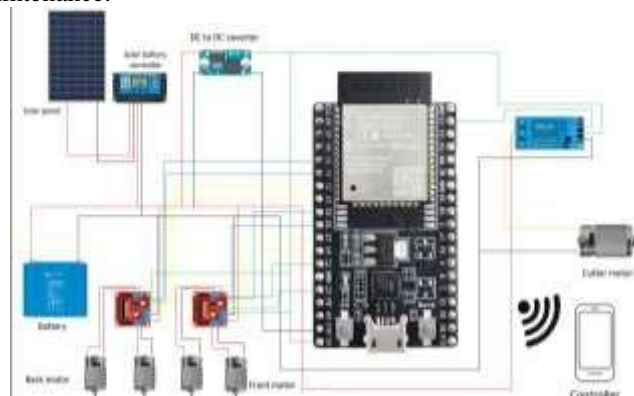


Fig 3.2 Schematic circuit of the proposed smart solar powered grass cutter with lawn coverage

### Components Used in Solar Automatic Grass Cutter

- Solar Panel- Converts solar energy into electrical energy and acts as the primary power source of the system.
- Solar Battery Charge Controller- Regulates the charging process of the battery and protects it from overcharging, deep discharge, and reverse current.
- Rechargeable Battery (Lithium-ion / Lead-acid)-Stores electrical energy and supplies power to the system during low or no sunlight conditions.
- DC-DC Converter (Buck Converter)- Steps down and regulates the battery voltage to a stable level suitable for the ESP32 and other electronic components.
- ESP32 Microcontroller- Acts as the central control unit of the system. It controls motor operations and provides built-in Wi-Fi connectivity for remote control.
- Motor Driver Modules (L298N / L293D)- Interface between the ESP32 and DC motors, enabling control of motor speed and direction.
- DC Motors (Front and Back Motors)- Drive the wheels of the grass cutter and enable movement in different directions.
- Relay Module- Used to safely switch the high-power cutter motor ON and OFF under the control of the ESP32.
- Cutter Motor- Drives the cutting blade at high speed for effective grass cutting.
- Cutter Blade- Performs the actual grass cutting operation.

- Wheels and Mechanical Frame- Provide structural support and mobility to the grass cutter.
- Connecting Wires and Accessories- Used for electrical connections between components.

#### 4. METHODOLOGY AND EXPERIMENTAL SETUP

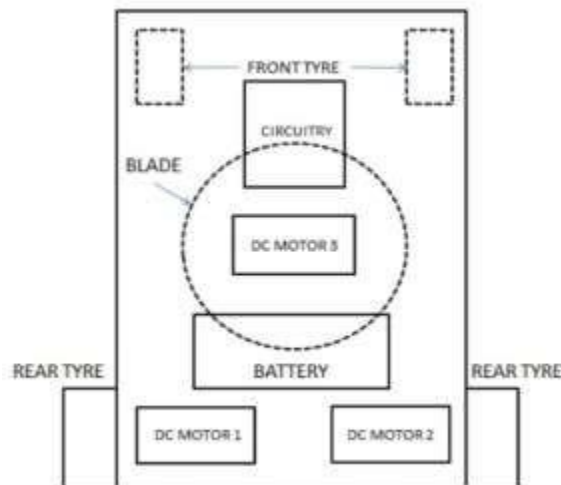
##### 4.1 Methodology

The methodology of the proposed solar automatic grass cutter is based on efficient physical arrangement of components, reliable power management, and controlled motor operation. As shown in the layout diagram, the system is designed with a balanced mechanical structure to ensure stability during movement and cutting. The front section of the system consists of the front tyres, which support directional movement. The control circuitry (ESP32) is placed near the centre of the chassis to reduce wiring length and improve signal reliability. The cutter blade is positioned centrally and is driven by DC Motor 3, allowing uniform grass cutting across the width of the machine. The battery is mounted near the centre-bottom of the chassis to maintain a low centre of gravity, enhancing stability during operation. Two DC motors (DC Motor 1 and DC Motor 2) are connected to the rear tyres to provide propulsion and manoeuvrability of the grass cutter. The ESP32 controls the wheel motors through motor driver modules and switches the cutter motor using a relay. Wi-Fi communication enables remote control and monitoring of the system. This methodology ensures efficient power utilization, balanced weight distribution, and reliable grass cutting performance.

##### 4.2 Experimental Setup

The experimental setup is implemented as shown in the physical layout diagram. All components are mounted securely on a rectangular chassis. The solar panel is mounted on the top surface to maximize sunlight exposure, while the battery, motors, and control circuitry are placed according to the layout for mechanical balance.

The rear wheel DC motors are fixed to the chassis and coupled to the rear tyres, while the front tyres support smooth directional movement. The cutter motor is mechanically coupled to the cutting blade and positioned at the centre for effective grass trimming. Electrical connections are made according to the circuit diagram, ensuring proper voltage regulation and safe motor operation. The system is tested under outdoor conditions to evaluate movement, cutting efficiency, and Wi-Fi-based control. The experimental results demonstrate stable operation and effective integration of mechanical design with electronic control.



**Fig. 4.1** Top View of Physical Layout of Solar Automatic Grass Cutter

The solar power supply and battery charging configuration used in the proposed system. The solar panel converts solar energy into electrical energy, which is regulated by the charge controller. The charge controller ensures safe charging of the 12 V battery by preventing overcharging and deep discharge.

Table: Hardware Implementation / 3D Model of Proposed System

Sr. no	Parameter	Value
1.	Solar panel voltage	12 V
2.	Battery voltage	12 V
3.	Controller supply voltage	5 V
4.	Motor operating voltage	12 V
5.	Charging method	Solar charge controller



**Fig. 4.2** Three-Dimensional View of Solar Automatic Grass Cutter

Fig. 4.2 illustrates the 3D CAD model of the proposed solar automatic grass cutter. The model highlights the structural frame, solar panel placement, battery compartment, motor assembly, wheel arrangement, and centrally mounted cutter blade used in the system.

## 5. EXPECTED RESULT AND DISCUSSION

The proposed solar automatic grass cutter is expected to demonstrate efficient and reliable operation using renewable solar energy. The integration of a solar panel with an effective energy management system is anticipated to reduce dependency on conventional power sources and lower operational costs. The system is expected to achieve smooth and controlled movement through DC motors, with stable navigation across flat lawn surfaces. The centrally mounted cutter blade driven by the cutter motor is expected to provide uniform grass cutting with minimal human intervention. Experimental validation and detailed performance analysis will be carried out after completion of the prototype.

Expected Performance of the Proposed System

Parameter	Expected Outcome
Power Source	Solar energy with battery backup
Battery Charging	Efficient charging under sunlight
Motor Operation	Smooth and controlled movement
Cutting Performance	Uniform grass cutting
Wi-Fi Control	Reliable remote operation
Energy Efficiency	Reduced power consumption

## 6. CONCLUSION

This paper presents the design and development of a solar automatic grass cutter aimed at providing an energy-efficient and environmentally friendly solution for lawn maintenance. The proposed system integrates solar power generation, efficient energy management, and Wi-Fi-based control using an ESP32 microcontroller.

The system architecture, circuit design, methodology, and experimental setup have been discussed in detail. Although the project is currently under development, the proposed design is expected to achieve reliable movement, effective grass cutting, and efficient utilization of solar energy. The integration of renewable energy reduces dependency on conventional power sources and minimizes operational costs. Future work will focus on completing hardware implementation, conducting experimental validation, and evaluating system performance under real-world conditions. The proposed system has the potential to offer a sustainable, cost-effective, and automated solution for lawn maintenance applications.

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